Subject: Geography CBCS HONOURS

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Semester: VI

CC14T: Disaster Management- Disaster Mapping

UNIT: I-POINT: 4.

Disaster prevention

A disaster occurs at the point of contact between social activities and a natural phenomenon of unusual scale.
Natural disasters occurring in larger scale may have a serious impact on society and the economy, resulting in a significant national loss.
Disaster prevention should be one of the most important policies of the Government of a country. "One who can rule rivers can rule a country, too" - An old theme of statesmanship.
Although, difficult to avoid natural phenomena such as rain and volcanoes, it is essential to understand their behavior and how we can live with them by reducing their impacts and to strengthen our ability to deal with their effects. Thus, we need to take measures for disaster prevention.
In short, disaster prevention is necessary to protect human lives, properties and social infrastructure against disaster phenomena.
One of the basic solutions to reduce the loss of life and damages is to remove the disaster phenomenon or the point of contact with the social activities. But it is often very difficult.
However, it is possible to moderate a phenomenon by taking measures:
- Reducing the likelihood of a phenomena, that is, removal of causes. For example, construction of levees and dams.
- Even if it does occur, it should not affect social activities. For example, elevate the foundation of houses.

♦ Five types of information necessary for disaster prevention

What: What occurs, what kind of phenomenon occurs? For example, a heavy rain causes a flood, a landslide or a debris flow. A volcanic eruption ejects a pyroclastic flow.

Where: Where does such a phenomenon appear? How extensive is the range of damage?

How: How large is the scale of phenomenon? How intense is it? For example, there is a heavy rain of 500mm in one day, or lava flow of 300,000 m^3. How does the phenomenon develop or spread? How does it come up? For example, there is a scenario of volcanic eruption such as Earthquake → Ash → Pyroclastic flow → Lava flow.

When: When does a phenomenon occur or when is it likely to occur? What is the frequency or probability of occurrence? For example, there is a heavy rain that occurs once for 30 years, or a great volcanic eruption that occurs once for 200 years.

Who: Who suffers from a disaster? How high is the grade of disaster? How many deaths, building damage or collapse? How much is the total loss?

Hazard map

♦ Functions of hazard map

The functions of a hazard map are to know the phenomenon and to make it known to residents. (Su Wu, a famous Chinese strategist, says “If you knows your enemy and yourself, you will not be in danger even in 100 combats.”)
The hazard maps cannot stop a disastrous phenomenon. But the effective use of hazard maps can decrease the magnitude of disasters.

♦ Objective of hazard map

The objective of hazard maps is to provide residents with the information on the range of possible damage and the disaster prevention activities. It is the important point to provide residents with understandable clear information.

♦ Types of hazard map

There are two types of hazard maps:

(1) Resident-educating type: This type of map has the main objective to inform the residents living within the damage forecast area of the risk of danger. The information on areas of danger or places of safety and the basic knowledge on disaster prevention are given to residents. Therefore, it is important that such information is represented in an understandable form.

(2) Administrative information type: This type of map is used as the basic materials that the administrative agencies utilize to provide disaster prevention services. These hazard maps can be used to establish a warning system and the evacuation system, as well as evidence for land use regulations. They may also be used in preventive works.

♦ Impacts of hazard map

All hazard maps are not unconditionally acceptable to residents. Landowners and land developers may fear about the fall of land prices and oppose to the public release of the maps. In addition, river administrators (within the Government) may oppose to the public release of the maps, fearing the criticism of residents that the administrators are neglecting preventive works even though they have a good understanding of the likelihood and consequences of potential disasters.

Examples of hazard maps

Now, I will introduce some examples of hazard map. All these have been collected via Internet.
- Floods
- Debris flows, Landslides, Slope failures
- Volcanic eruption (lava flow, pyroclastic flow, ash fall)
- Earthquake, Tidal waves ("tsunami")

♦ Examples of flood hazard map
This flood hazard map was prepared by Wakayama Construction Work Office under the Ministry of Land, Infrastructure and Transport and publicly released on Internet. This map

shows the flooded areas by water depth. The location of flooded land is indicated clearly. Wakayama City is located here.

♦ Debris flow hazard map example

This map is published by Shizuoka Prefecture on Internet, and it is a GIS.
There are small streams running along the mountains, and there are hazardous areas distributed just under these mountains.

♦ Volcanic hazard map example

This map was created in 1995 and released by a town named Sobetsu-cho in Hokkaido. This Mount Usu erupted in 2000, but caused no human casualties.
♦ Earthquake hazard map example
This map was prepared by Nagano Prefecture Office to forecast the seismic strength. Here is the area with highest earthquake vulnerability.
Natural conditions of Japan
Now, I will briefly describe the natural conditions of Japan and disasters. Japan has 70% of total land area as mountains with many steep rivers. The areas of high population density are concentrated on narrow plains. The yearly average rainfall reaches 1750mm. The flows of rivers are often high. Once we have a heavy rain, a flood, slope failure and debris flow occur concurrently. In addition, our country is located near the plate boundary. So there are 86 active volcanoes. The Izu Miyake Island erupted in 2000 and all the residents on the island have been evacuated. In Japan, we have many earthquakes every year and in 1995, Kobe here suffered a tremendous disaster.

Hazard map creating procedure (1)

As I have explained, Japan has the natural conditions which make it susceptible to disasters. Therefore, in Japan disaster prevention is a necessity. The technology to support disaster prevention has been developed.
First of all, it is necessary to know the past history of disasters before creating a hazard map. Also, the measured data such as rainfall should be arranged so as to ensure sound statistical analysis. The topographic and geologic studies to trace the evidence of disasters should be made in the field where necessary. The results of these activities are represented in the form of a map. This map is called a disaster record map.
Landform maps are also an important information source. Flood plains, alluvial fans, mountains and valleys are formed through past floods, earthquakes and volcanic activities.
If you cannot produce a quantitative hazard map, as I explain later, landform maps can be useful instead of a hazard map. If you use aerial photos or satellite data, you can produce a landform map easily even though no topographic map is available. From the viewpoint of disaster prevention, I would recommend you to produce such landform map, which may be called “a disaster factor map”.

Hazard map creating procedure (2)

The procedure of creating a hazard map can be divided into three processes:

(1) Forecasting a range of disaster: To define the subject phenomenon and its scale and forecast the range of disaster using the digital simulation technology.
(2) Collecting the disaster-related information to be inserted in the hazard map and representing the information in the hazard map.

(3) Publishing the maps by distributing directly to people or through Internet or by any other means. Then, the disaster prevention activity will start using the hazard map.

- A flood is caused by a heavy rain. So rainfall is forecast. The rainfall pattern is defined based on the past records of heavy rains and statistical calculations. In Japan, a heavy rain that may occur once for 100 years is often assumed for this purpose.
- It is calculated how high the discharge is in case of such heavy rain. This is called runoff analysis.
- The cross-sections of a river are collected to depict its cross-sectional views and calculate the limit flow that a river can have. This is called flow capacity.
- If the runoff quantity of a river is higher than its flow capacity, the river is flooded. Then, the flooded location and the discharge can be defined.
- The water movement of a flood flow is calculated in digital computation using a elevation model of a floodplain. This is called flood simulation, and the calculated results are water depth and flow velocity.
- The calculated results are represented in a map.

Considerations in creating a hazard map

- As a hazard map is created, the topographic map of the subject area is required. The topographic models and photographic maps that can be acquired from a satellite may be used.
- It is necessary that the data for which any potential phenomenon can be forecast is made based on sound scientific methods.
- As the objective of a hazard map is to inform residents of a potential disaster, the map should be created with the representations and contents that are understandable to non-professional people.
- The digital analysis that I have introduced you before should be supported by complete data so there is a considerable cost in carrying out the calculations. No matter how high the data accuracy is, the digital computation is a forecast. This is something that cannot be represented by computations. In addition, if any phenomenon and its scale are different from the forecast ones, the range of disaster will also be different. Such cases will occur and there is no case in which a disaster occurs as shown in a hazard map. Thus, it is necessary to recognize the limitation of these hazard maps.
- Digital analysis is not the only method. A disaster history and a disaster geomorphological land classification map are also important information for disaster prevention. Therefore, it is necessary to combine these for use in forecasting a disaster pattern. However, the geomorphological land classification map has a disadvantage that the scale of a phenomenon is not clear.

Contents of a hazard map

The contents which can be inserted in a hazard map are the following, though it is unnecessary to include all items, They can be selected depending on the purpose:

- A base map is required. As the base map, a topographic map or a photographic map (ortho-photos) can be used. The topographic map is more effective to understand the information for a hazard map than ortho-photos. A photographic map contains too much information to interpret it.

- Disaster prevention information is the most important information that should be provided to residents. Mainly, the forecast area of disaster should be included and the past disaster records may be included as needed. Or, the map can be divided into both types.

- The second information to be disseminated to residents is evacuation-related information. The location of refuges and evacuation routes to be used in case of a disaster are shown in the map. Residents can see their evacuation route and places of refuge from the hazard map. In addition, the system and instructions to accurately warn of an impending disaster and appropriate evacuation procedures to residents are also described in the map, such as for example, a forecasting siren or a warning siren.
- The behavior of disaster phenomena and the basic knowledge on natural phenomena are also described.

Hazard maps and GIS

Hazard maps are very compatible with GIS. First, the GIS is very useful in arranging a high volume of data necessary to produce a hazard map. Then, it can be used for analysis of places of refuge. Three-dimensional representations are available. Digital cartography is also available. So, it is possible to test a method of creating an easy to read hazard map. Recently, there have been cases where maps are publicly released using the Internet GIS technology.
Hazard maps and preventive measures

(1) General

The use of hazard maps is one of the means for disaster prevention. Producing a hazard map is not the final goal. Then, what should be done when a hazard map is completed? It is mainly used to disseminate information about the hazardous areas for residents and to help them act on warning and evacuating measures.

(2) Publication, dissemination and education in the use of hazard maps

A hazard map is significant only when it is publicly released to residents. They can be used residents in evacuation and when their lives are in danger. Administrations should make efforts to repeatedly disseminate disaster prevention information to residents by means of hazard maps. It is necessary to furnish residents with school education and disaster prevention training once a year or more and repeatedly disseminate the disaster prevention information through various methods. It is better to plan events which will increase the resident's participation.

(3) Hazard maps and preventive works

Hazard maps are not directly related to preventive works, but using hazard maps, it is possible to estimate the cost of damages due to a disaster. Further, hazard maps can be used for the economic evaluation of a preventive work and for Benefit Cost (B/C) analysis. As a result, the priority order of preventive works can be determined.

(4) **Importance of monitoring and data collection**

As I described in the hazard map creating procedures, it is necessary to collect basic data for creating a hazard map. It is necessary not only to know the past disaster history, but also to collect the data that is statistically significant to estimate the scale of a phenomenon and to determine the criteria for forecasting and warning. Flood forecast requires rainfall and flow measurements. A seismograph is also required to predict an earthquake. An earthquake may occur around a volcano and a debris flow and a mudflow come up if a heavy rain falls. If the terrain is complicated, the disaster phenomena will be variable and complex. The designated places for refuge should be safe against all types of disaster. Therefore, it is necessary to integrate hazard maps to effectively respond to these different types of disaster.

Administrative agencies have to undertake the shared functions that are different in national, prefectural and village levels. Police, public works, press and transport have individual functions, but tie-ups among these functions are needed. In short, a total disaster prevention plan is necessary.

Climatic disasters that have occurred in various areas of the world may have been affected by global warming. If so, disaster prevention is not a problem in the regional and national level, but it should be considered in the global level. The global tie-up and cooperation in disaster prevention beyond regions and countries are needed to sustain the life on the Earth.

References:

Regional Workshop on Total Disaster Risk Management 7-9 August 2002

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